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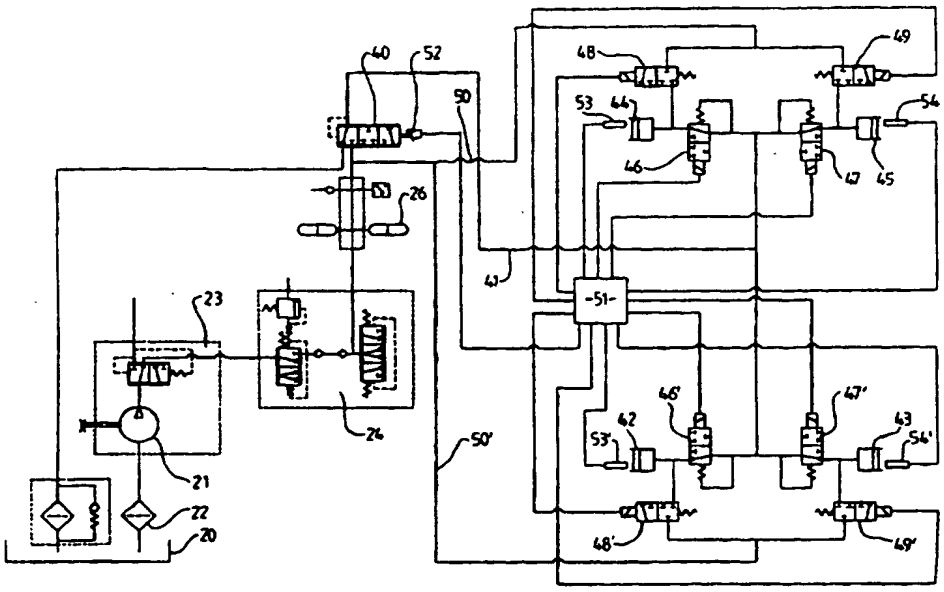

(57) Abstract

A loader vehicle (10) including means (51, 53, 53', 54, 54') for detecting slipping of each of a plurality of wheels (11, 12) of the vehicle (10), and means (46, 46', 47, 47', 48, 48', 49, 49', 50, 50', 51) for causing application of a brake (42-45, 65) at each said wheel (11, 12) at least to reduce such slipping.

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LOADER TYPE VEHICLE WITH TRACTION CONTROL

Description of Invention

This invention relates to wheeled vehicles of the loader type. By such vehicles, we mean those which are intended for use primarily in the agricultural or industrial field, particularly in the latter case in the construction industry, for load handling. Commonly such vehicles incorporate features such as a boom assembly which is preferably a telescopic or otherwise extendable boom assembly which may comprise a single boom or a pair of side-by-side booms provided with load handling equipment such as a bucket, platform, fork frame, or the like, and when we refer herein to a loader vehicle it is to be understood that we intend to include all vehicles of that general type and not to be limited to any specific type of vehicle.

Loader vehicles frequently work on loose and/or soft ground surfaces, and problems can arise when one or more of the wheels of the vehicle fail to grip the surface on which the vehicle is working. Even when a four-wheeled loader vehicle has all four wheels drivable, the differential gears necessarily incorporated in the vehicle's drive line mean that if one wheel should lose grip and spin then little or no torque is applied at the other wheels, and the vehicle cannot move under its own power. It is not the common practice to fit loader vehicles with limited slip differentials which would overcome such a problem, because they limit the overall manoeuvrability of the vehicle.

It is broadly the object of the present invention to provide a loader vehicle in which this disadvantage of hitherto known loader vehicles is overcome or reduced.

According to one aspect of the present invention, we provide a loader vehicle including means for detecting slipping on each of a plurality of wheels of the vehicle, and means for causing application of a brake at each said wheel at least to reduce such slipping.

In a loader vehicle according to the invention, brake application at a wheel or wheels where slipping is detected has the effect of ensuring that the or each other driven wheel or wheels which is not slipping is driven through the differential gear or gears of the vehicle, so that the vehicle can still move under its own power.

Preferably the brake which is applied at a wheel when slipping thereof is detected is a service brake which is provided in operative association with the wheel for braking in normal use of the vehicle. Preferably such a brake is fluid pressure operable, and the vehicle is provided with means whereby fluid under pressure may be supplied from a source thereof to the brake by way of modulating valve means which may be controlled by the vehicle's driver to determine the pressure of fluid applied to the brake and thus the level of braking attained.

Preferably the vehicle has a service braking system comprising respective first conduit means for supply of fluid under pressure from said modulating valve means to the brake at a respective drivable wheel of the vehicle, and blocking valve means for blocking said first conduit means upon detection of wheel slipping to enable fluid under pressure to be provided to said brake from said supply of fluid by way of a respective slipping control valve means and second conduit means.

Preferably the slipping control valve means comprises, for each wheel, a valve able to control flow of fluid in proportion to an electrical signal applied to the valve.

Preferably the vehicle includes an electrical control means which is arranged to apply to each of said slipping control valve means a signal in the form of a series of pulses whose width and/or frequency may determine the rate at which fluid is passed by each such valve means and thus to control the level of brake application caused thereby.

Alternatively, the slipping control valve means may be operable simply between open and closed conditions, in which case the blocking valve means may

provide for controlling flow of fluid from the brakes back to a reservoir thereof in accordance with an electrical signal (e.g. a pulsed signal as aforesaid) applied to the blocking valve means, thereby to control the level of brake application.

The means for detection of wheel slipping preferably comprises means for measuring the speed of each driven wheel of the vehicle and means for comparing the speeds thus measured with one another. A difference between such speeds greater than that caused by maximum steering of the vehicle is indicative of slipping, and the control means may then cause brake application at the or each wheel whose speed compared with another appropriate wheel or wheels of the vehicle is excessive.

The speed of each wheel whose speed measurement is required may be measured by any convenient sensor of known type provided at each such wheel turning either at the same speed as the vehicle's wheel or at a speed proportional thereto. Such a sensor may be a magnetically-operating sensor, e.g. a Hall effect sensor, disposed in close proximity to the element which may be a toothed wheel. Such an element may be provided on a hub part or a drive shaft part associated with the vehicle's wheel.

The vehicle may be provided with a safe loader indicator device operable to cause at least one brake of the vehicle to be applied so that the vehicle cannot bew driven when a safe load is exceeded.

The vehicle may be provided with a device for carrying a person and means to detect said device or the presence of a person in said device and operable to cause at least one brake of the vehicle to be applied in response to said detection.

The invention will now be described by way of example with reference to the accompanying drawings, of which:-

Figure 1 is a side view of a loader vehicle to which the invention may be applied;

Figure 2 shows diagrammatically the hydraulic system of a conventional such loader vehicle;

Figure 3 shows diagrammatically the part of the hydraulic system of the vehicle pertaining to the brakes thereof, and incorporating the present invention;

Figure 4 shows diagrammatically a hub assembly of a steerable wheel of the loader vehicle, and illustrates where wheel speed sensors may be fitted in order to equip the vehicle in accordance with the invention;

Figure 5 shows diagrammatically the control algorithm of a control means of the braking system of the vehicle incorporating the invention.

Referring firstly to Figure 1 of the drawings, a loader vehicle is illustrated generally at 10. It has four ground engaging wheels including front wheels 11 and rear wheels 12. The wheels are carried at the ends of axles supported relative to a chassis of the vehicle and either the rear wheels only of the vehicle or all the wheels thereof may be steerable. The vehicle includes an engine and a transmission system by which two only of its wheels, e.g. the front wheels, may be driven or all four wheels may be driven. The vehicle has a cab for accommodation of the vehicle's driver, such cab being indicated generally at 13.

For load handling, the vehicle has a boom 14 which is pivoted to the structure of the vehicle at 15 and is able to be raised and lowered by a hydraulic ram or rams under the control of the vehicle driver. The boom 14 is telescopically extensible, again by a hydraulic ram or rams under the control of the vehicle's driver. At the free end of the boom, there is a load handling device which in the illustrated embodiment comprises a fork frame 16 for engagement with loads of appropriate type.

Referring now to Figure 2 of the drawings, this shows diagrammatically the entire hydraulic system of a loader vehicle such as described above. In Figure 2, a reservoir of hydraulic fluid is indicated at 20 and fluid is drawn from such reservoir by an engine driven pump 21 by way of a strainer 22. Fluid is delivered by the pump to a load-sensing valve 23 whence it is supplied to a charge valve arrangement 24 and a steering valve 25. The charge valve 24 controls supply of

fluid under pressure to a pressurised reservoir 26 wherein the fluid is maintained under a predetermined pressure for operating the braking system of the vehicle to be described hereafter.

The steering valve 25 is controlled by the steering wheel of the vehicle and controls supply of fluid under pressure to front and rear powered track rods 28, 29 respectively for steering the wheels on the front axle and the rear axle of the vehicle. A steering mode valve 30 enables the steering to be switched between two wheel steering mode and four wheel steering mode: in the former the rear wheels only are steered while in the latter both the front and rear wheels are steered.

From the charge valve 24 hydraulic fluid is also supplied to a valve block 31 containing a number of valves under the control of the driver of the vehicle, to cause flow of hydraulic fluid in the appropriate sense to further hydraulic rams 32, 33, 34 and 35 which respectively cause telescopic extension and retraction of the boom of the vehicle, displacement and tilting in the appropriate sense of the load handling device carried by the boom to cause it either to pick up a load or dump or place down a load, and raising and lowering of the boom. There are also outlets from the valve 31 leading to other optional hydraulically operated items of equipment which may be provided on the loader.

Referring now to Figure 3 of the drawings, this shows diagrammatically the fluid pressure operated braking system of the loader vehicle, partly as shown in Figure 2 but additionally incorporating a wheel slip control means in accordance with the present invention. In Figure 3, the pump 21, suction strainer 22, load sensing valve 23, and charge valve 24 and pressurised fluid reservoir 26 are shown, as in Figure 2.

A modulating valve 40 is under the control of the driver of the vehicle, being operated preferably by a foot pedal. The modulating valve, when depressed by the driver, provides for supply of fluid firstly by way of a common conduit 41 and then by way of individual brake pipes to brakes 42, 43 for the rear wheels of the vehicle and brakes 44, 45 for the front wheels of the vehicle. The pressure

of fluid applied to the brakes is determined by the pressure exerted by the driver on the foot pedal which operates the modulating valve. In the individual brake pipes respectively leading to the left and right front brakes 44, 45 there are respective blocking valves 46, 47 and after the valves 46, 47 the pipes leading to the respective brakes are branched to connect to respective slipping control valves 48, 49. The slipping control valves 48, 49 are further connected to a pipe 50 leading to the reservoir 26 of fluid under pressure.

If the rear wheels of the vehicle also are drivable, the individual brake pipes leading to the left and right rear brakes 42, 43 are provided with blocking valves 46 ', 47 ' and there are slipping control valves 48 ', 49 'and a pipe 50 ', all connected in the same manner as for such valves for the brakes at the front wheels of the vehicle.

The blocking valves 46, 47, 46 ', 47 ' are solenoid-operated valves which when their solenoids are de-energised are open and when energised are closed. The slipping control valves 48, 49, 48 ', 49 ' are solenoid operated valves which when their solenoids are de-energised are closed, but which when their solenoids are energised are opened by movement of a valve member away from a seating therein.

There is also an electrical control system which includes a central processing unit indicated at 51 which has inputs from a switch 52 associated with the modulating valve 40, and left and right hand front wheel speed sensors 53, 54 which are arranged to measure the speed of the left hand and right hand front wheels respectively. There are also left and right hand rear wheel speed sensors 53 ', 54 ' providing inputs to the processing unit 51. Outputs from the processing unit 51 are connected to the blocking valves 46, 47, 46 ', 47 ' and the slipping control valves 48, 49, 48 ', 49 '. The processing unit 51 is preferably a micro-processor based unit and includes software which may operate as described hereafter with reference to Figure 5 of the drawings.

Figure 4 illustrates an example of a steerable hub assembly of the type which commonly is utilised in loader-type vehicles. Hub assemblies of this type

are generally well known and therefore it will not be described herein in great detail, but its principal components comprise a body 60 which has upper and lower yoke portions 61, 62 for connection by suitable swivel bearings to an axle body part not shown, the hub body when thus connected being able to undergo steering swivel movement relative to the axle body part about a steering axis 63. The body 60 rotatably supports a hub 64 and inside the hub 64 there is a multiplate brake indicated generally at 65 and a planetary reduction gear indicated generally at 66. The planetary reduction gear 66 provides a driving connection between the hub 64 and an input shaft 67 which is connected by a double Hookes universal joint 68 to an axle shaft 69.

In order to measure the speed of a wheel carried by the hub 64 as shown in Figure 4, a wheel speed sensor is provided which is conveniently a magnetically-operating sensor such as a Hall effect sensor, disposed in close proximity to a wheel of toothed or other non-circular configuration provided on a rotating part of the hub assembly. Such a sensor may be mounted on the axle body part which carries the steerable hub assembly, and the toothed wheel with which it cooperates provided on the axle shaft 69, or on the adjacent yoke of the double Hookes universal joint 68 or on the centre yoke of such joint. Possible such locations of the toothed wheel are indicated at 70 in Figure 4. It will be appreciated that the rotational speed measured by a sensor thus positioned is not equal to the rotational speed of the wheel carried by the hub assembly because of the interposition of the planetary reduction gearing 66 but since it bears a fixed relationship to the wheel speed the signal, suitable processed, provides a measure of wheel speed.

In broad terms, the method of operation of the vehicle braking system as above described is that when the vehicle is being braked under the control of the vehicle's driver, the switch 52 associated with the brake modulating valve 40 provides an electrical signal to the processing unit 51 to indicate that this is the case. The processing unit 51 provides no output to the valves 46, 47, 48, 49 (and if present 46 ', 47 ', 48 ', 49 ') which remain in their normal, non-energised, states

as above referred to. The brake system operates under the driver's control as if these were not present.

When the vehicle is being driven but not braked, the signal to this effect provided by the switch 52 enables the central processing unit 51 to control the valves 46, 48 or 47, 49 in such a manner as to eliminate or reduce wheel slipping if this should start to occur.

A suitable control algorithm in accordance with which the central processing unit 51 may operate is shown in Figure 5 of the drawings. It will be appreciated that the processing unit 51 receives signals from the respective wheel speed sensors, from the modulating valve brake switch 52, and also from a switch which is operated when the slipping reduction system in accordance with the invention (traction control) is to be brought into use. At the start of a cycle, all input signals to the processing unit 51 are read, and an initial step is to derive an average vehicle speed by adding the wheel speed signals provided by the sensors 53, 54 and dividing this sum by two, assuming the front wheels only of the vehicle are being driven. If the speed thus derived is within a range which it has been predetermined is one in which the wheel slip control is to be permitted to operate, (e.g. between 0.5 metres per second and 3 metres per second), then the processing unit proceeds to carry out the next step of the control algorithm. If the speed is outside this range, then the processing unit returns to the start of its operating cycle, and no further action is taken to detect or control wheel slip.

The next step is that it is determined whether the slipping redirection system, as mentioned above, is in operation. If it is, then the next test is carried out, which is whether the vehicle is being braked by the driver. If the vehicle is being braked by the driver (as indicated by a "no" answer to the question "is brake switch false?") then the processing unit 51 again returns to the start of its algorithm, ensuring that the blocking valves 46, 47 are not energised.

The next operating step is that it is determined whether the wheel speeds detected by sensors 53, 54 are substantially equal (for example whether their speeds differ from one another by more than 10%). If the speeds are equal,

then the algorithm returns to its start, again ensuring that the blocking valves 46, 47 are de-energised.

If the wheel speeds are not equal, then it is determined whether it is the left hand or right hand wheel whose speed is the greatest. If it is the right hand wheel whose speed is greatest, i.e. if it is the right hand wheel which is slipping, then the right hand blocking valve 47 is energised to close it and the right hand slipping control valve 49 is energised with a pulsed signal. If it is the left hand wheel which is slipping, then the left hand blocking valve and slipping control valve are energised as aforesaid.

If the rear wheels as well as the front wheels of the vehicle are being driven, then the speeds of the rear wheels are taken into account and if slipping thereof is detected the valves 46', 47', 48', 49' are actuated as appropriate.

Preferably the appropriate slipping control valve (or valves) is energised with an electrical signal in the form of a series of pulses at a frequency of, for example, 10 Hz. This enables the braking effort provided at the appropriate wheel to be appropriately controlled to bring wheel slip under control.

As an alternative to controlling the braking effort provided at the appropriate wheel by energising the slipping control valves with a pulsed electrical signal, it would be possible for such valves to be energised with a continuous signal so that they are fully opened when required. In this case, the blocking valves 46, 47, 46', 47' would be used to control the brake application by determining the rate at which fluid is returned to the reservoir 20 by way of the conduit 41 and modulating valve 40 (which latter valve, when the brakes are not being applied by the vehicle's driver, permits such return). Suitable modulating valves would have to be used for the blocking valves, and the processing unit 51 would be arranged to provide for appropriate energisation thereof.

The above described algorithm with which the processing unit 51 operates is undergone at predetermined intervals, and the above described brake

application by way of the slipping control valves is caused to take place each time wheel slipping is detected in the cycle.

It is known for loader-type vehicles of the kind to which the present invention relates to be fitted with a safe load indicator device. Such a device may operate by detecting the load carried on the wheels of the vehicle which are furthest away from the load handling equipment of the vehicle, and detect whether the weight borne by such wheels is reduced below a minimum safe value. Clearly, if the load being carried by the vehicle were large enough to lift those wheels of the vehicle clear of the ground it would be extremely dangerous as control of the vehicle and load would be lost.

In a vehicle having a slipping control system in accordance with the invention, operation of the safe load indicator system to indicate that the load is not safe may cause at least one brake of the vehicle to be applied so that the vehicle can not be driven. This would be achieved by providing the control algorithm in accordance with which the central processing unit operates with a further step in which the signal from the safe load indicating means is examined and acted upon accordingly.

It is possible for a loader type vehicle of the kind to which the present invention relates and provided with a telescopic boom to be provided with a man-basket, that is to say, a device for carrying one or more persons and able to be raised to an elevated position for access purposes. Driving of the vehicle whilst a man-basket is in use would be dangerous, and accordingly in a vehicle having a slipping control system in accordance with the invention operation of a suitable means for detecting that the man-basket is in use may cause the vehicle's brakes to be applied so that the vehicle cannot be driven.

As in the case of a safe load indicator system as above referred to, the control algorithm in accordance with which the central processing unit operates may be provided with a further step in which a signal indicating whether or not the man-basket is safe is examined and acted upon accordingly. Such a signal

may be provided by a switch detecting occupation of the man-basket, or, for example, detecting presence of the man-basket and elevation thereof.

Figure 5 shows as an inset further steps which may be provided in the control algorithm. These steps may be included in the algorithm where indicated, after the "Is brake switch false?" step. In the first additional step, in which the question "Is SLI false?" is asked, a "Yes" answer which indicates that the load is within safe limits enables the algorithm to proceed to the next step. This next additional step asks the question "Is man-basket safe?" and if it is found that the man-basket is safe then the next step of checking for substantially equal wheel speeds is carried out.

In the event of a "No" answer to either of the additional steps of the algorithm, then the processing unit causes the lock-out valve and slipping control valves to apply the brakes to prevent the vehicle being driven.

As an alternative to incorporate the steps of testing for safe load and man-basket safety in the control algorithm of the slipping control system, the safe load indicating means and/or man-basket safety detector could be hard-wired in association with the lock-out and slipping control valves to set such valves to condition in which the brakes are applied if the load is not safe or the man-basket is not safe.

The features disclosed in the foregoing description, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS

1. A loader vehicle including means for detecting slipping of each of a plurality of wheels of the vehicle, and means for causing application of a brake at each said wheel at least to reduce such slipping.

2. A vehicle according to claim 1 wherein a brake which is applied at the wheel when slipping thereof is detected is a service brake which is provided in operative association with the wheel for braking in normal use of the vehicle.

3. A vehicle according to claim 1 or claim 2 wherein said brake is fluid pressure operable, and the vehicle is provided with means whereby fluid under pressure may be supplied from a source thereof to the brake by way of modulating valve means.

4. A vehicle according to claim 3 wherein the modulating valve means is controlled by the vehicle's driver to determine the pressure of fluid applied to the brake and thus the level of braking attained.

5. A vehicle according to any one of claims 2 to 4 wherein the vehicle has a service braking system comprising respective first conduit means for supply of fluid under pressure from said modulating valve means to the brake at a respective drivable wheel of the vehicle, and blocking valve means for blocking said first conduit means upon detection of wheel slipping to enable fluid under pressure to be provided to said brake from said supply of fluid by way of a respective slipping control valve means and second conduit means.

6. A vehicle according to claim 5 wherein the slipping control valve means comprises a valve means to control flow of fluid in proportion to an electrical signal applied to the valve.

7. A vehicle according to claim 5 or claim 6 wherein the vehicle includes an electrical control means which is arranged to apply to each of said slipping control valve means a signal in the form of a series of pulses.

8. A vehicle according to claim 7 wherein the width and/or frequency of the said pulses determines the rate at which fluid is passed by the slip control valve means checking to control the level of brake application.

9. A vehicle according to claim 5 wherein the slipping control valve means is operable between open and closed conditions and the blocking valve means provides for control of flow of fluid from the brakes back to a reservoir thereof in accordance with an electrical signal applied to the blocking valve means.

10. A vehicle according to claim 9 wherein the electrical signal comprises a series of pulses wherein the width and/or frequency of said pulses determines the rate at which fluid is passed by the blocking valve means thereby to control the level of brake application.

11. A vehicle according to any one of the preceding claims wherein the means for detection of wheel slipping comprises means for measuring the speed of each driven wheel of the vehicle and means for comparing the speeds thus measured with one another.

12. A vehicle according to claim 11 wherein the difference between said speeds greater than that caused by maximum steering of the vehicle is indicative of slipping and the control means causes brake application at the or each wheel whose speed compared with another appropriate wheel or wheels of the vehicle is excessive.

13. A vehicle according to any one of the preceding claims wherein the speed of each wheel whose speed measurement is required is measured by a sensor provided at each such wheel and responsive to an element turning either at the same speed as the vehicle's wheel or at a speed proportional thereto.

14. A vehicle according to claim 13 wherein the element is provided on a hub part or a drive shaft part associated with the vehicle's wheel.

15. A vehicle according to any one of the preceding claims wherein the vehicle is provided with a safe loader indicator device operable to cause at least one brake of the vehicle to be applied so that the vehicle cannot be driven when a safe load is exceeded.

16. A vehicle according to any one of the preceding claims wherein the vehicle is provided with a device for carrying a person and means to detect said device or the presence of a person in said device and operable to cause at least one brake of the vehicle to be applied in response to said detection.

17. A vehicle substantially as hereinbefore described with reference to the drawings.

18. Any novel feature or novel combination of features described herein and/or in the accompanying drawings.

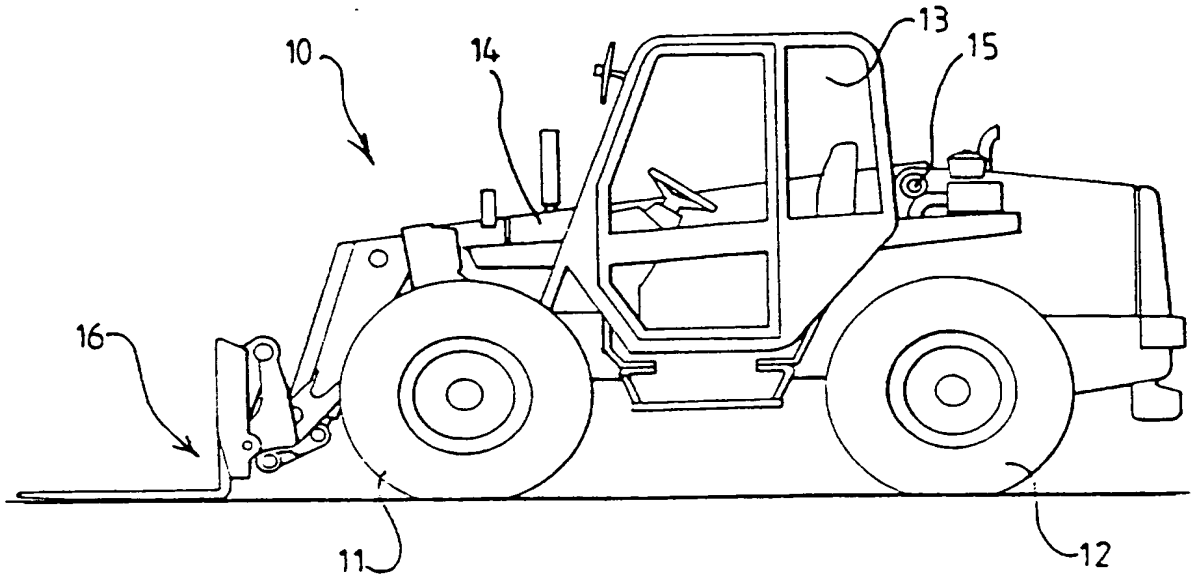

FIG 1

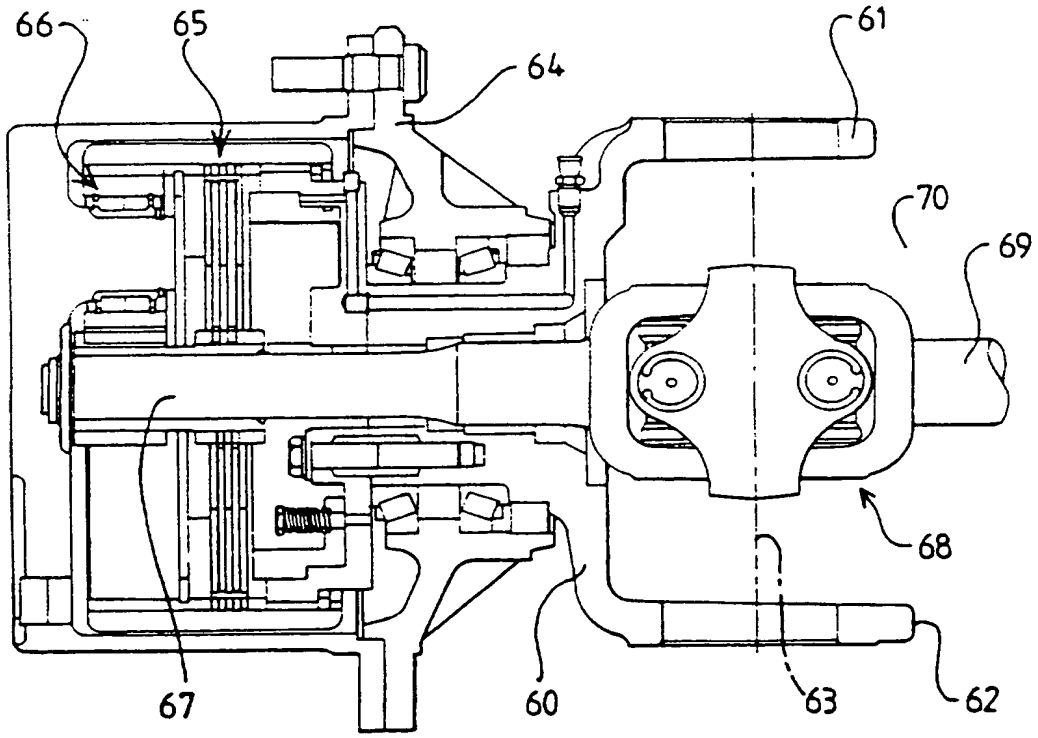

FIG 4

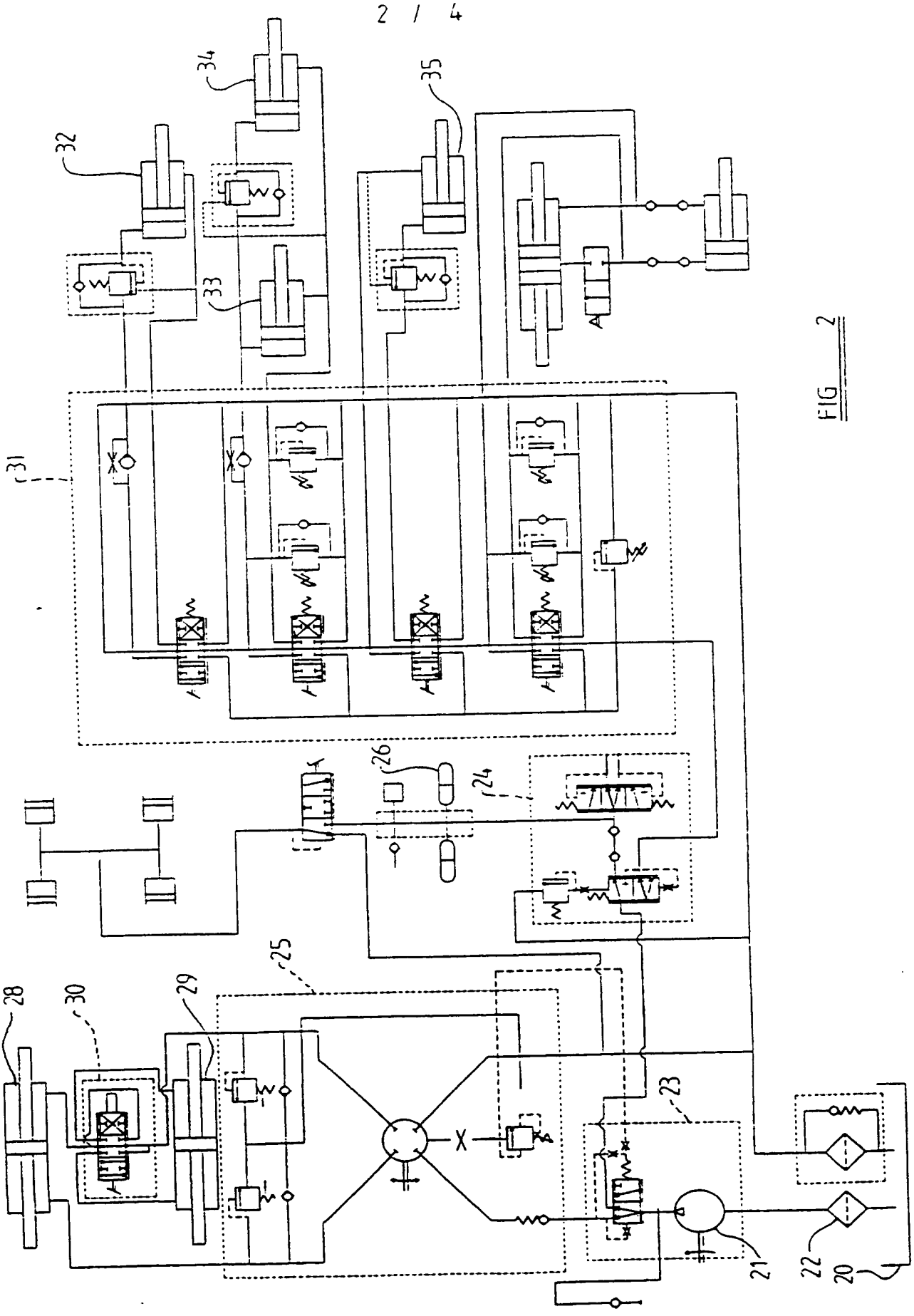

FIG 2

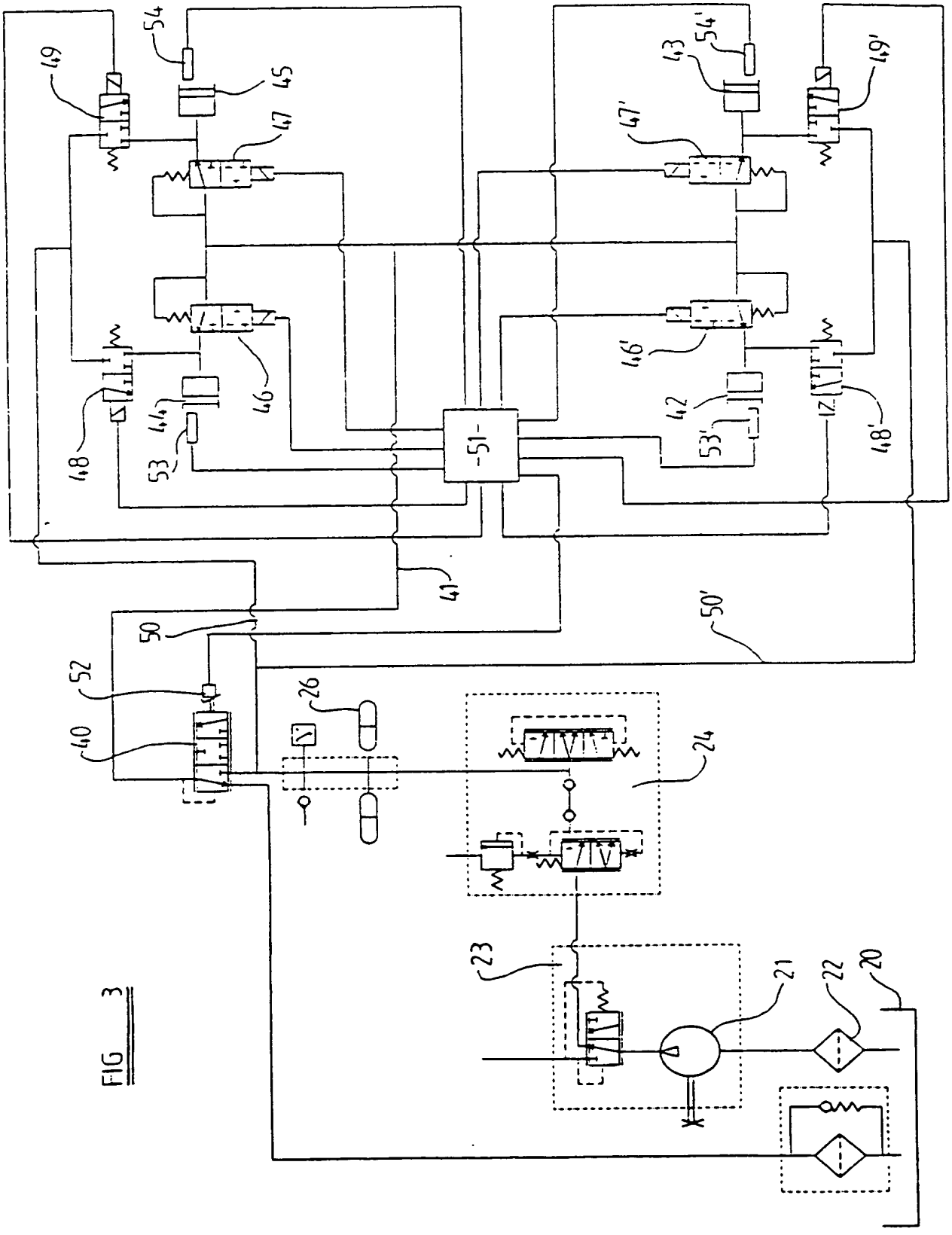
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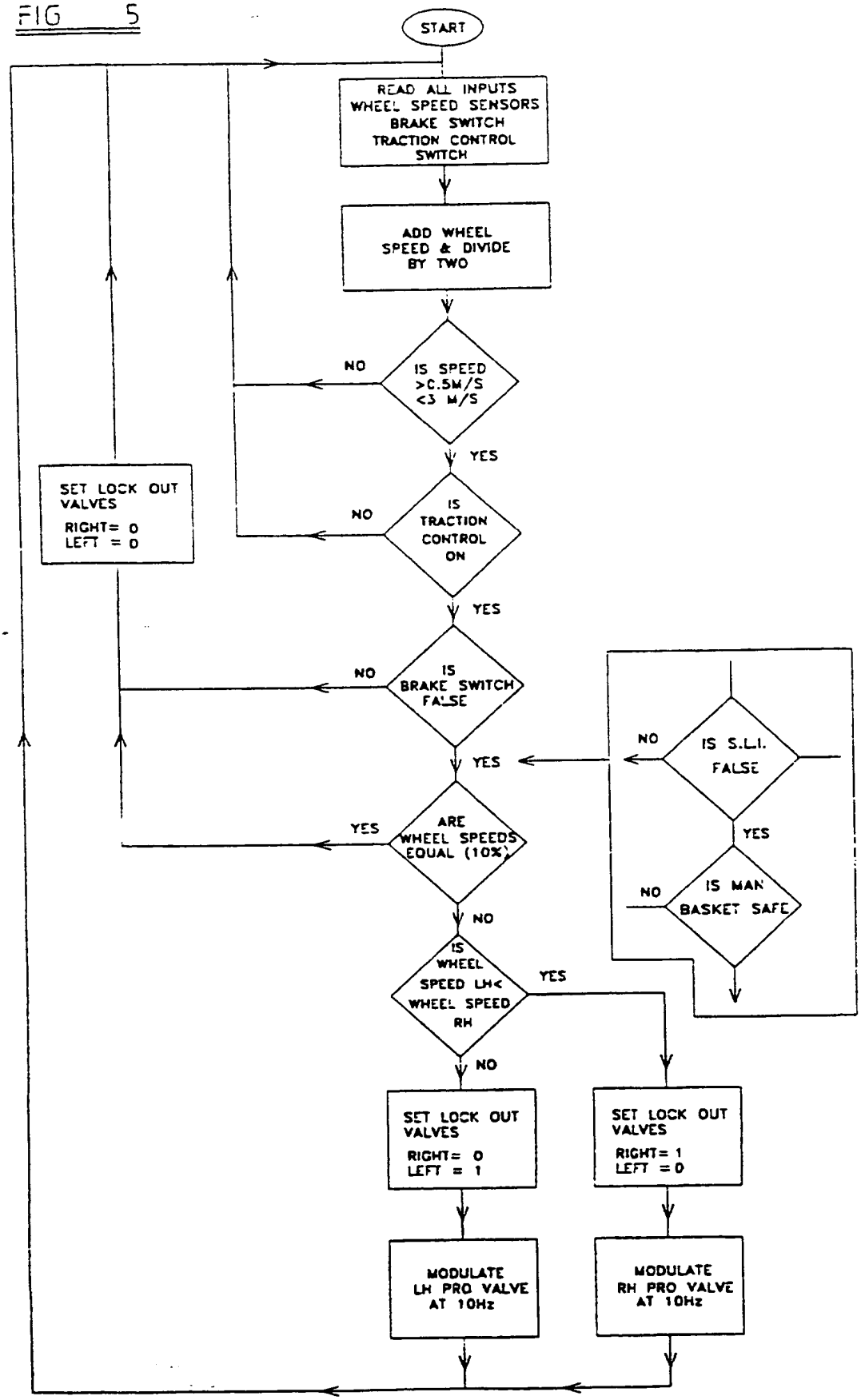
FIG 3

FIG 5


START
READ ALL INPUTS
WHEEL SPEED SENSORS
BRAKE SWITCH
TRACTION CONTROL SWITCH
ADD WHEEL SPEED & DIVIDE BY TWO
IS SPEED >0.5M/S <3 M/S
NO
YES
IS TRACTION CONTROL ON
NO
YES
SET LOCK OUT VALVES
RIGHT= 0
LEFT = 0
IS BRAKE SWITCH FALSE
NO
YES
IS S.L.I. FALSE
NO
YES
IS MAN BASKET SAFE
NO
YES
ARE WHEEL SPEEDS EQUAL (10%)
YES
NO
IS WHEEL SPEED LH< WHEEL SPEED RH
YES
NO
SET LOCK OUT VALVES
RIGHT= 0
LEFT = 1
SET LOCK OUT VALVES
RIGHT= 1
LEFT = 0
MODULATE LH PRO VALVE AT 10Hz
MODULATE RH PRO VALVE AT 10Hz

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 96/02515

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60T8/48 B60T7/12 B66F9/065

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 06 795 B (HANS STILL A.G.) 18 April 1957 see the whole document ---	1-4
X	GB 919 786 A (CATERPILLAR) 27 February 1963 see the whole document ---	1-4,11, 13,14
X	GB 1 361 425 A (ALFRED TEVES) 24 July 1974 see page 1, line 9 - page 3, line 42; figures 1,2 ---	1-5,9, 11-13
Y		9,10
X	GB 2 020 382 A (WABCO FAHRZEUGBREMSEN) 14 November 1979 see the whole document ---	1-8,11, 13
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 January 1997	01. 04. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	MEIJS, P

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 181 502 A (PERRY ET AL.) 23 April 1987 see page 1, line 5 - page 2, line 39 ---	1,2, 11-13
X	EP 0 498 355 A (EATON CORP.) 12 August 1992 see column 1, line 5 - column 2, line 11 see column 6, line 14 - line 20 see column 7, line 56 - column 8, line 38; figure 1 ---	1-8,11, 13,14
X	WO 95 19282 A (ITT INDUSTRIES) 20 July 1995 see abstract; figures 1,2 see page 7, line 10 - page 9, line 8 ---	1-3,13 9,10
Y A	US 4 658 189 A (TRUSOCK) 14 April 1987 see abstract; figure 1 -----	

1

INTERNATIONAL SEARCH REPORT

mational application No.
PCT/GB 96/ 02515

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

CLAIMS 1-14 : LOADER VEHICLE WITH TRACTION CONTROL
CLAIMS 15 AND 16 : LOADER VEHICLE WHEEL BRAKE APPLICATION UNDER SPECIFIED LOADING CONDITION.

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-14

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 96/02515

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